Gray whale abundance from shore-based counts

John Durban
Dave Weller, Aimee Lang,
Wayne Perryman

NOAA Southwest Fisheries Science Center

Advice

Dave Rugh, Rod Hobbs, Jeff Breiwick
Jeff Laake, Paul Wade
NOAA Alaska Fisheries Science Center

Andre Punt
*University of Washington*

Steve Reilly
[formerly] NOAA Southerwest Fisheries Science Center

Supporting documents

Durban, Weller, Lang, Perryman. 2015. **Estimating gray whale abundance from shore-based counts using a multilevel Bayesian model**. Journal of Cetacean Research and Management, in press.

Durban, Lang, Weller, Rugh, Hobbs, Perryman. 2010. **Comparing two methods of shore-based counts of eastern North Pacific gray whales**. Paper SC/62/BRG8 presented to the International Whaling Commission, Scientific Committee.

Gray whale migration
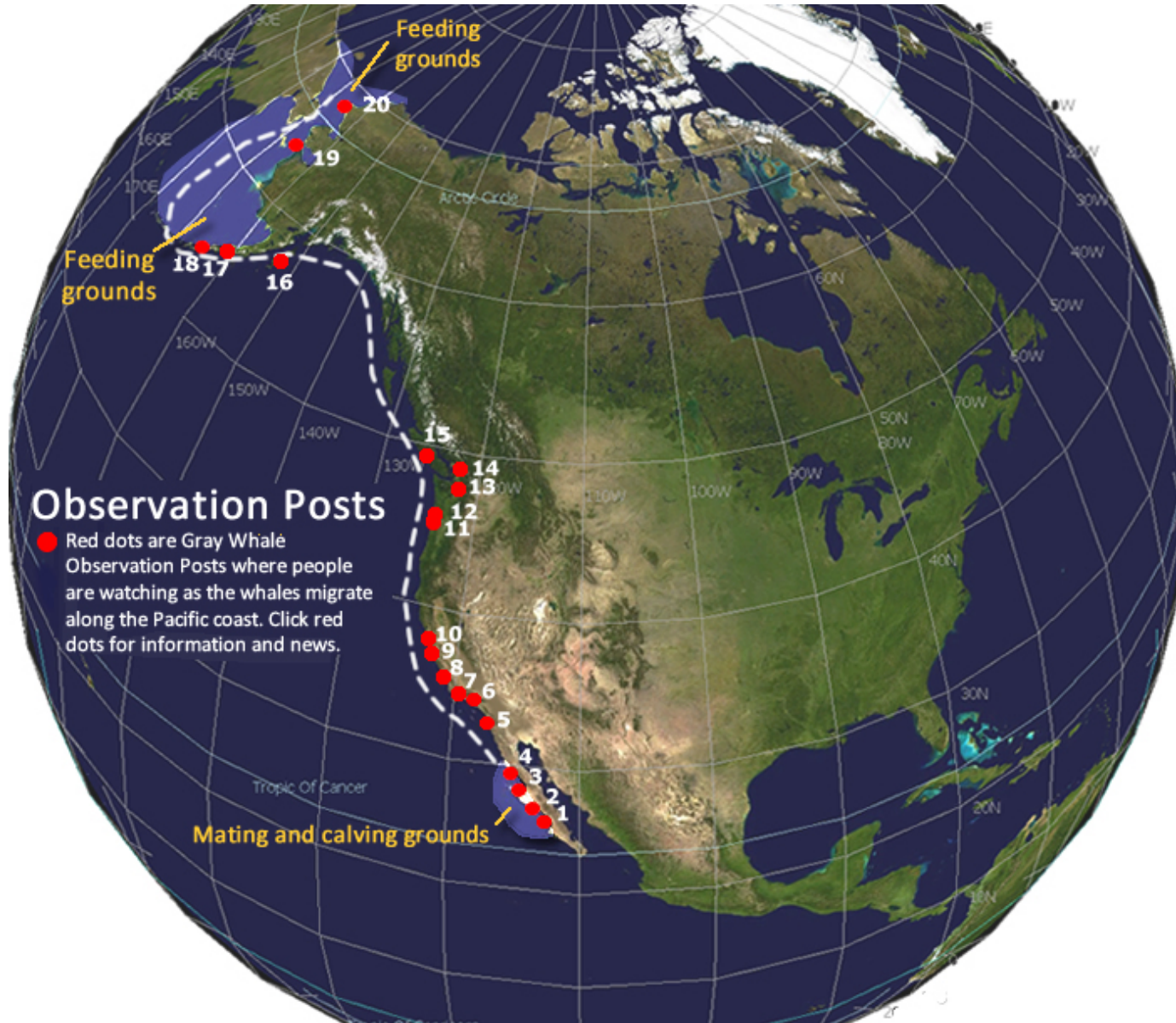
Close to shore to avoid predators

Shore-based counts, since 1967

Previous estimation procedure

Correct for pod-size (calibration, subjectivity)

Whales missed during watches (observer detections)

Whales missed outside of watches (migration curve)

Correction for night-time travel rate (faster at night)

Matching independent counts

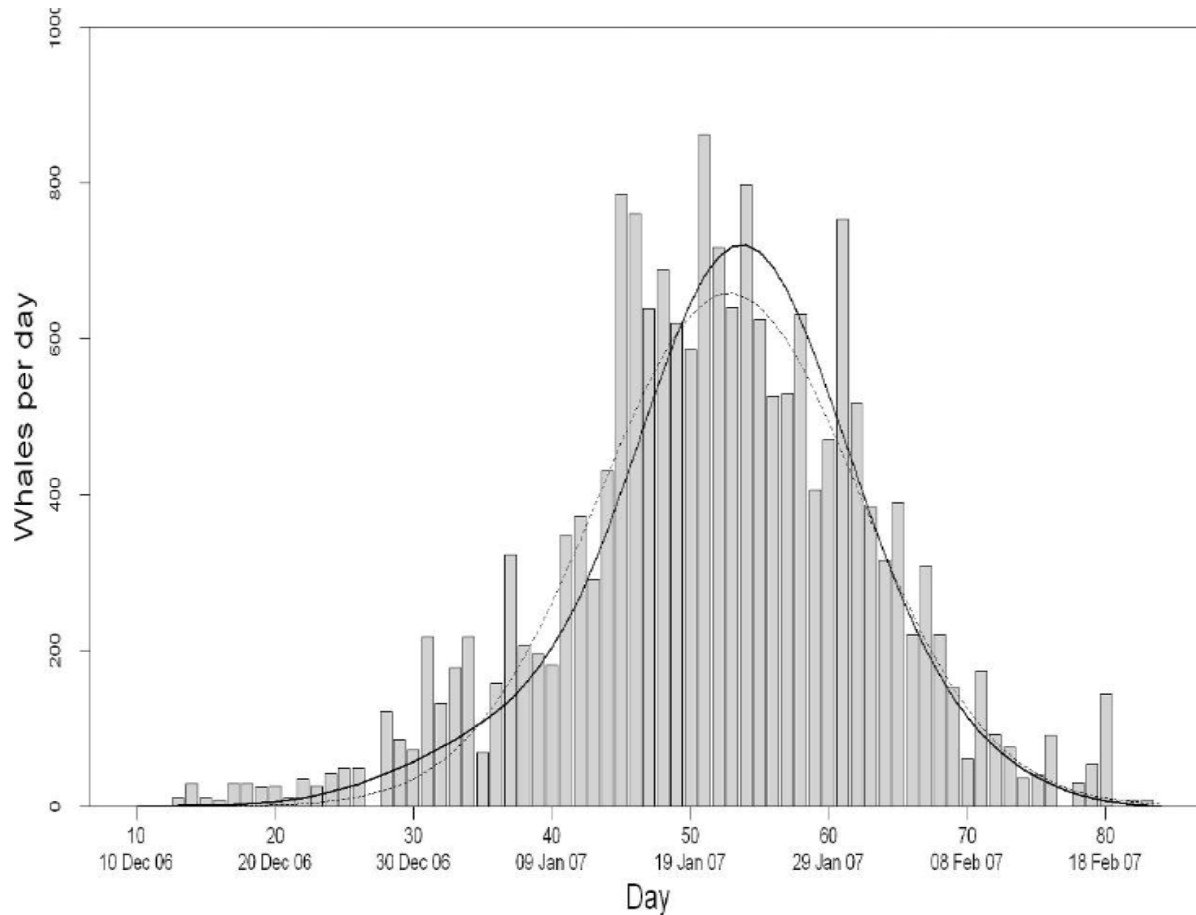Missed pods quantified by matched detections between observers

Multiple pods hard to track by a single observer with paper records

Observer subjectivity in pod size
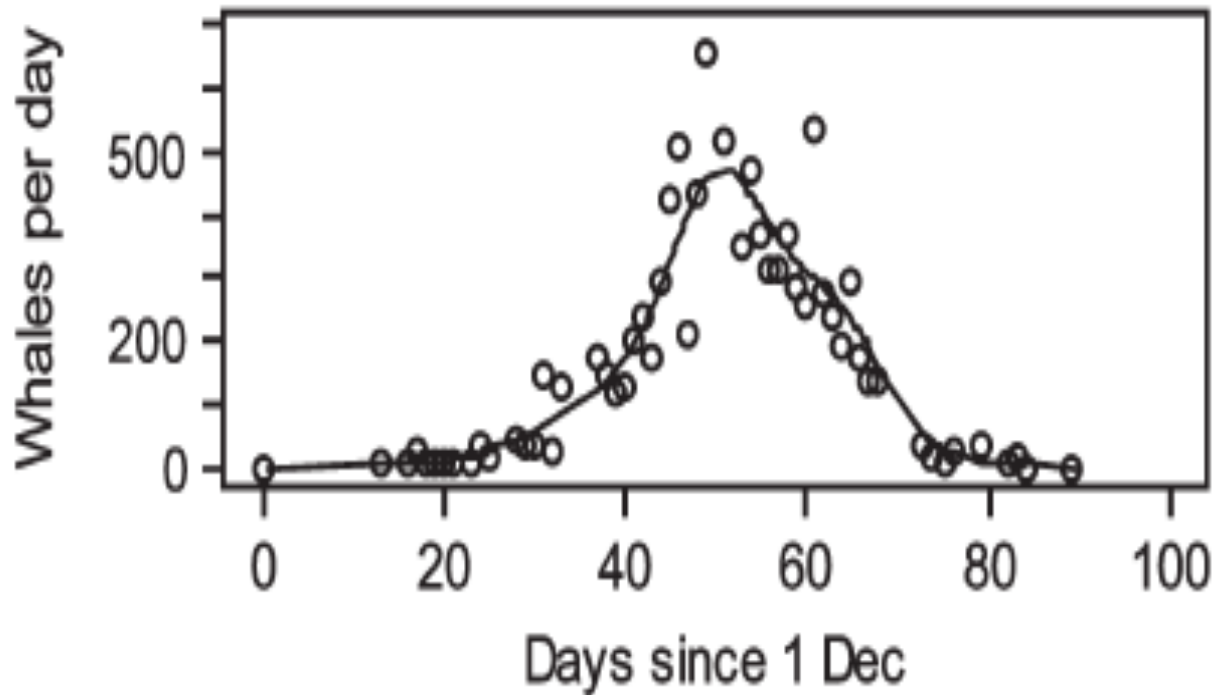
Difficult to match sightings between observers

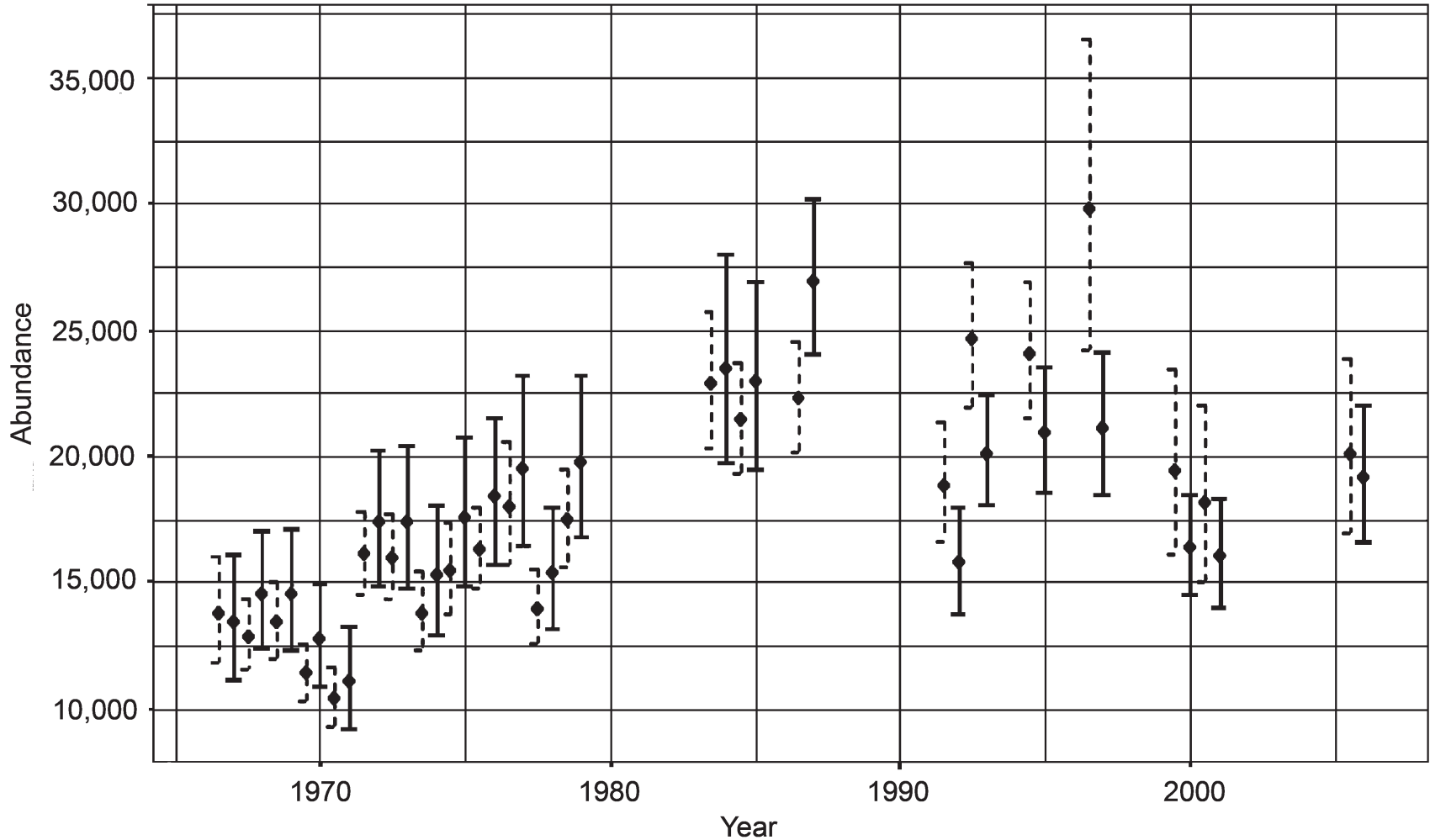# Migration curve

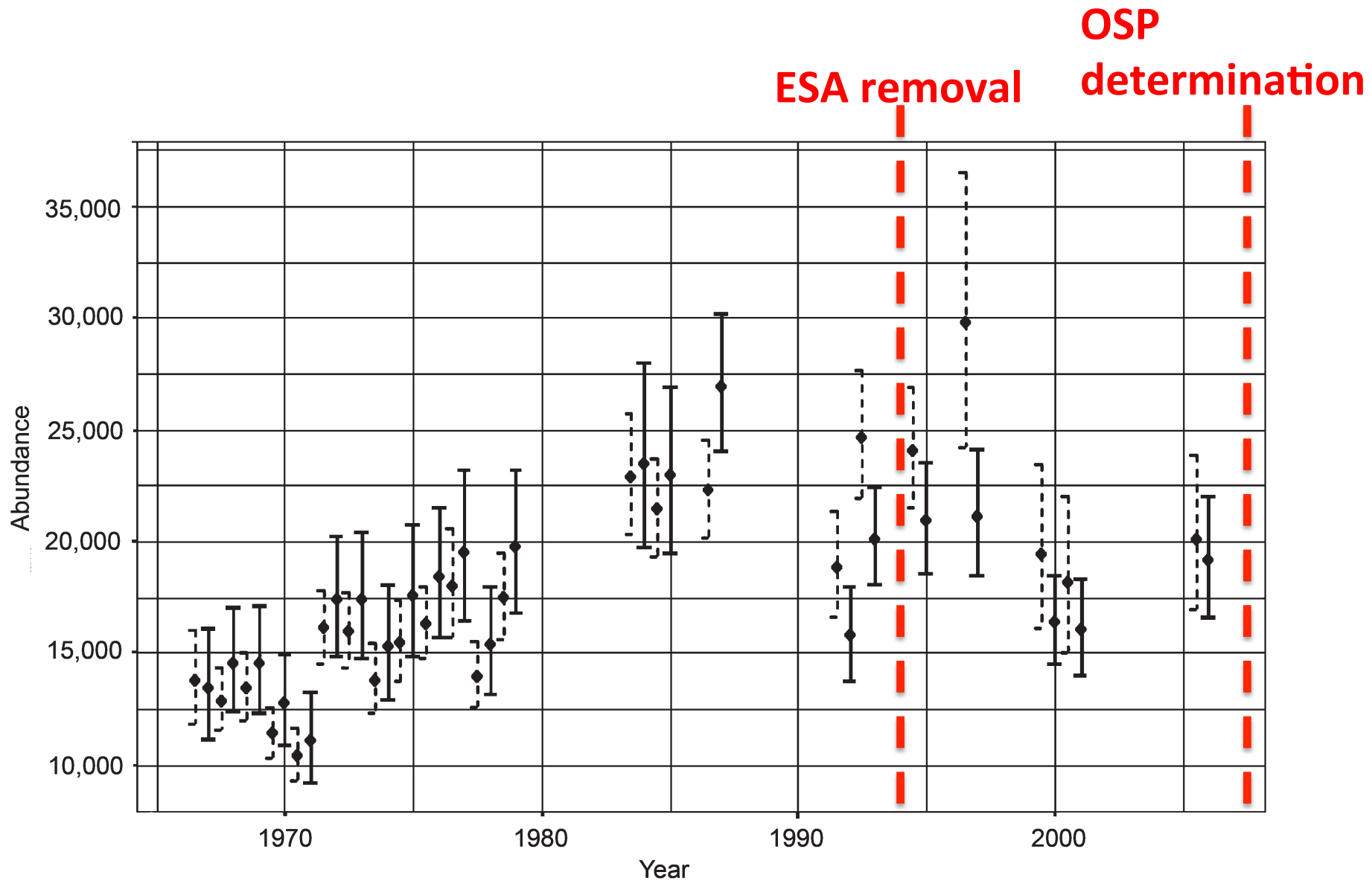Might assume common distributional form

(e.g. Normal curve)

Rugh et al. 2008. AFSC Processed Report 2008-03

Migration curve

Or non-parametric curve-fitting

Laake et al. 2012. J. Cetacan Res. Manage 12: 287–306

Monitoring recovery

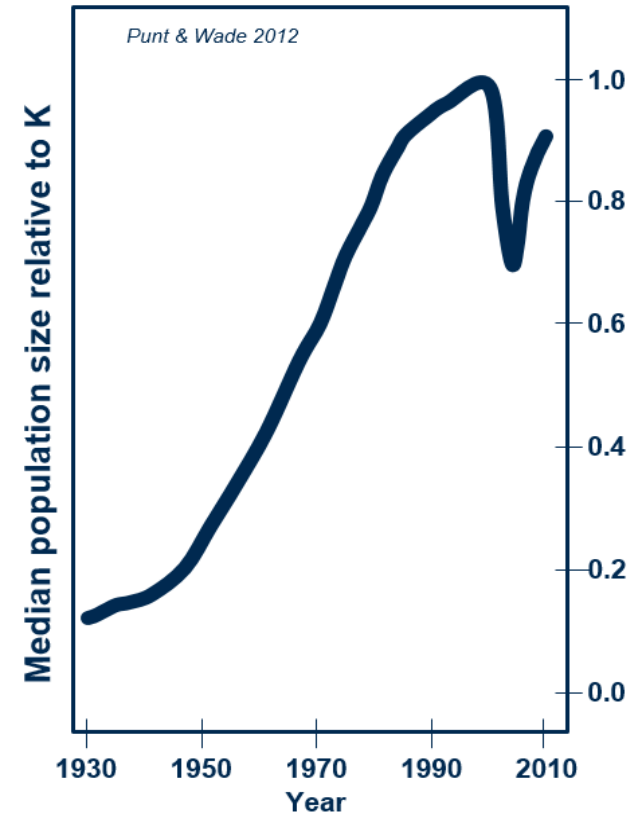*Laake et al. 2012. J. Cetacan Res. Manage 12: 287–306*

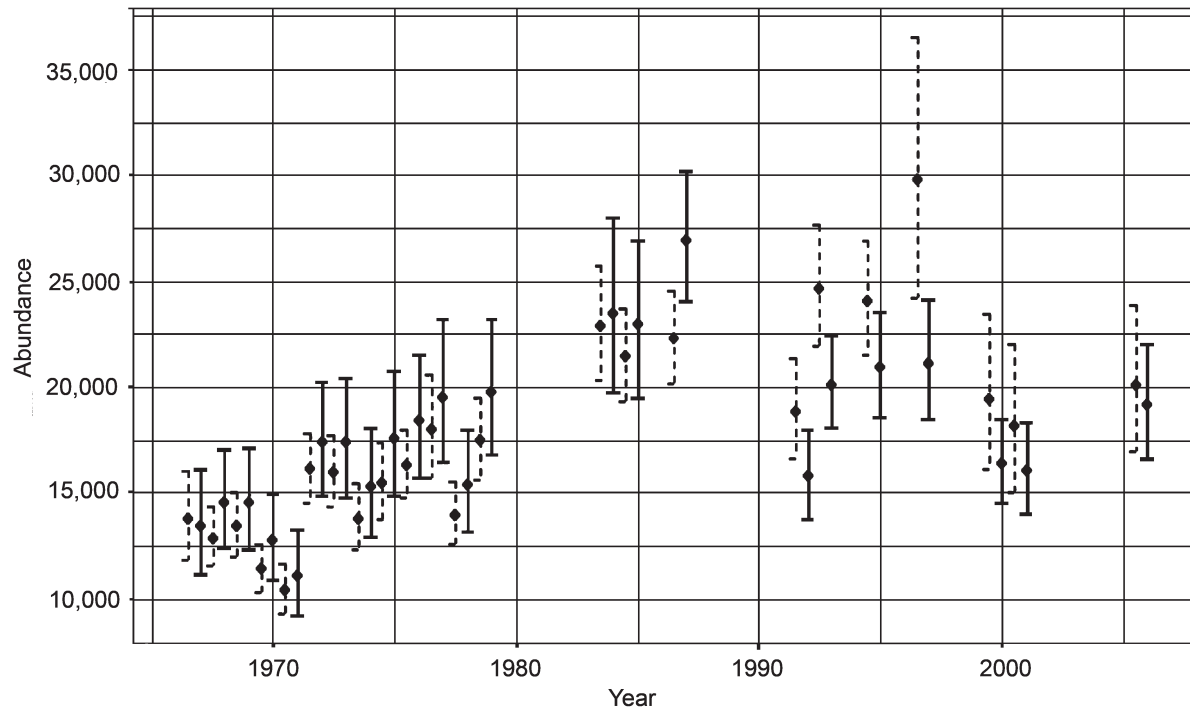*Laake et al. 2012. J. Cetacan Res. Manage 12: 287–306*

A management need

Abundance and status assessments used in draft EIS to evaluate whale harvests requested by Makah Tribe.

www.westcoast.fisheries.noaa.gov/ protected_species/marine_mammals/ cetaceans/whale_hunt.html

Evolving statistical methods

Statistical approaches have evolved over time

Latest re-analysis after 2007

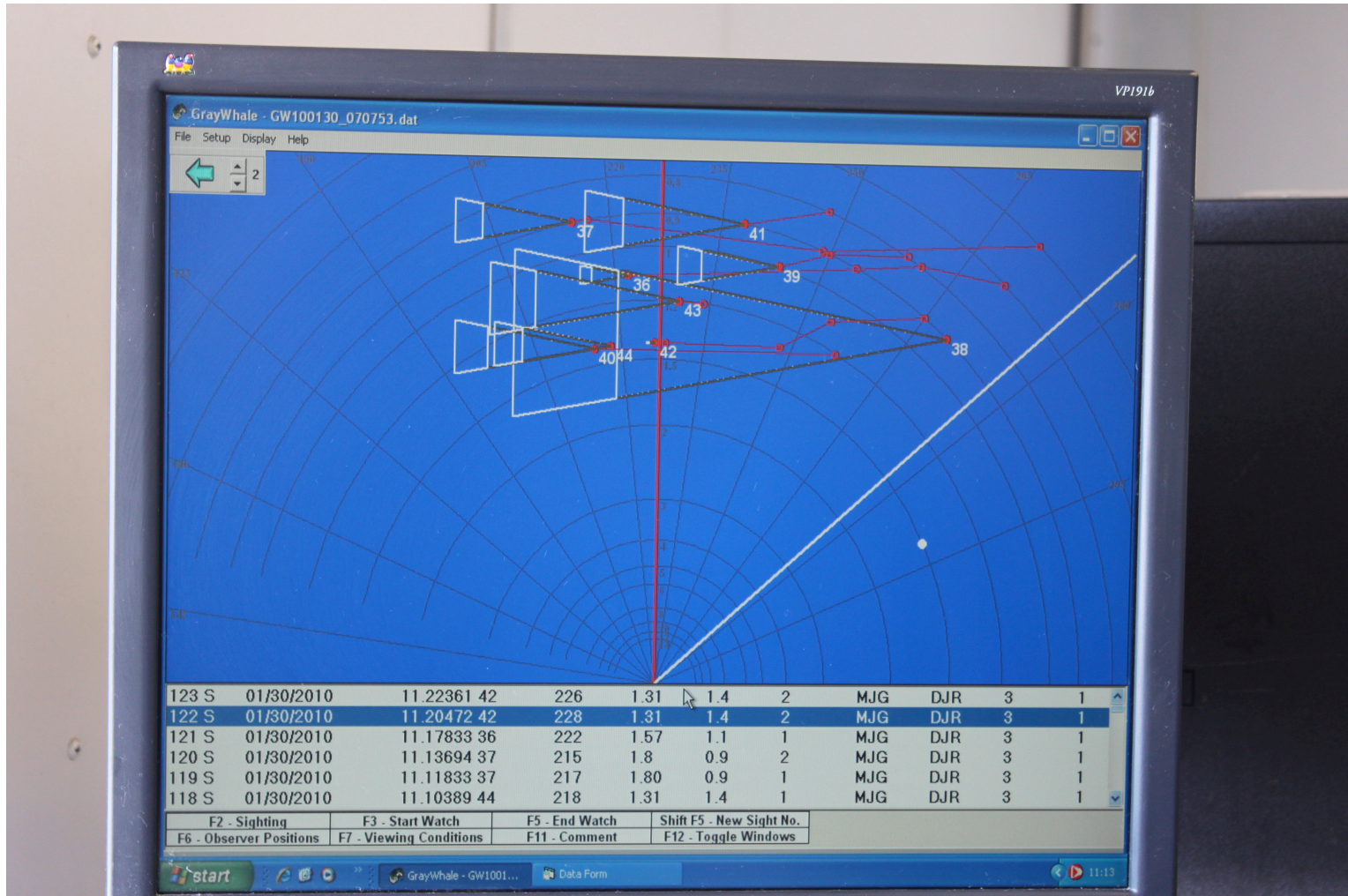Need to match field protocols with robust analysis tools

Laake et al. 2012. J. Cetacan Res. Manage 12: 287–306

The MMTD team approach

A paired team of observers work together to better track and enumerate pods
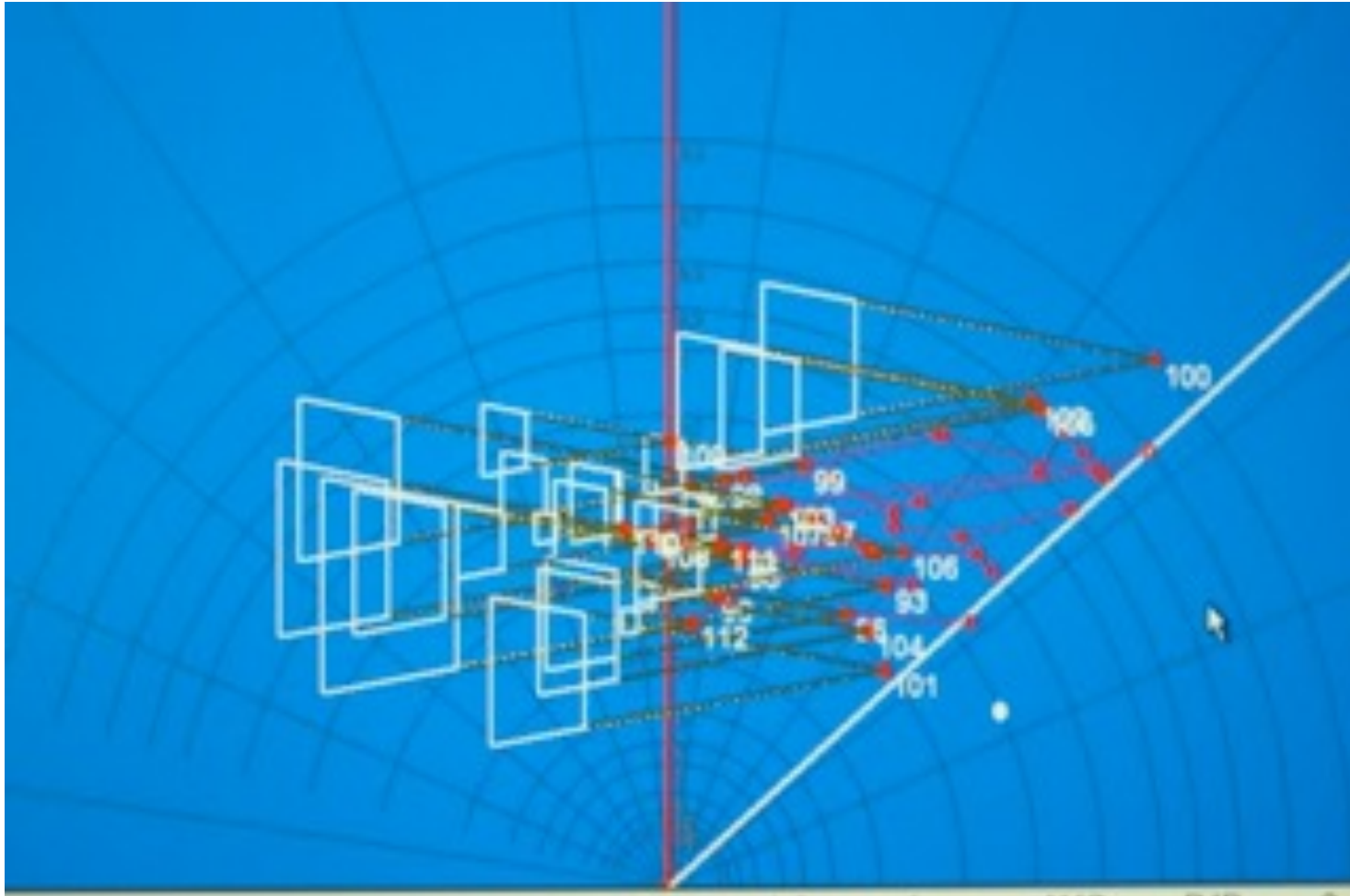
Computer assistance

Computer software facilitates real-time pod tracking and enables more repeat observations of each pod, refining pod size estimates.

Evolving counting methods

Hard to track separate groups during busy times with a single observer using paper records – needed refinement of old counting approach

Comparative counts

In a comparison, MMTD observer teams counted fewer singles and more larger groups, helped by repeated observations. There was variability between the single observers using the old method.
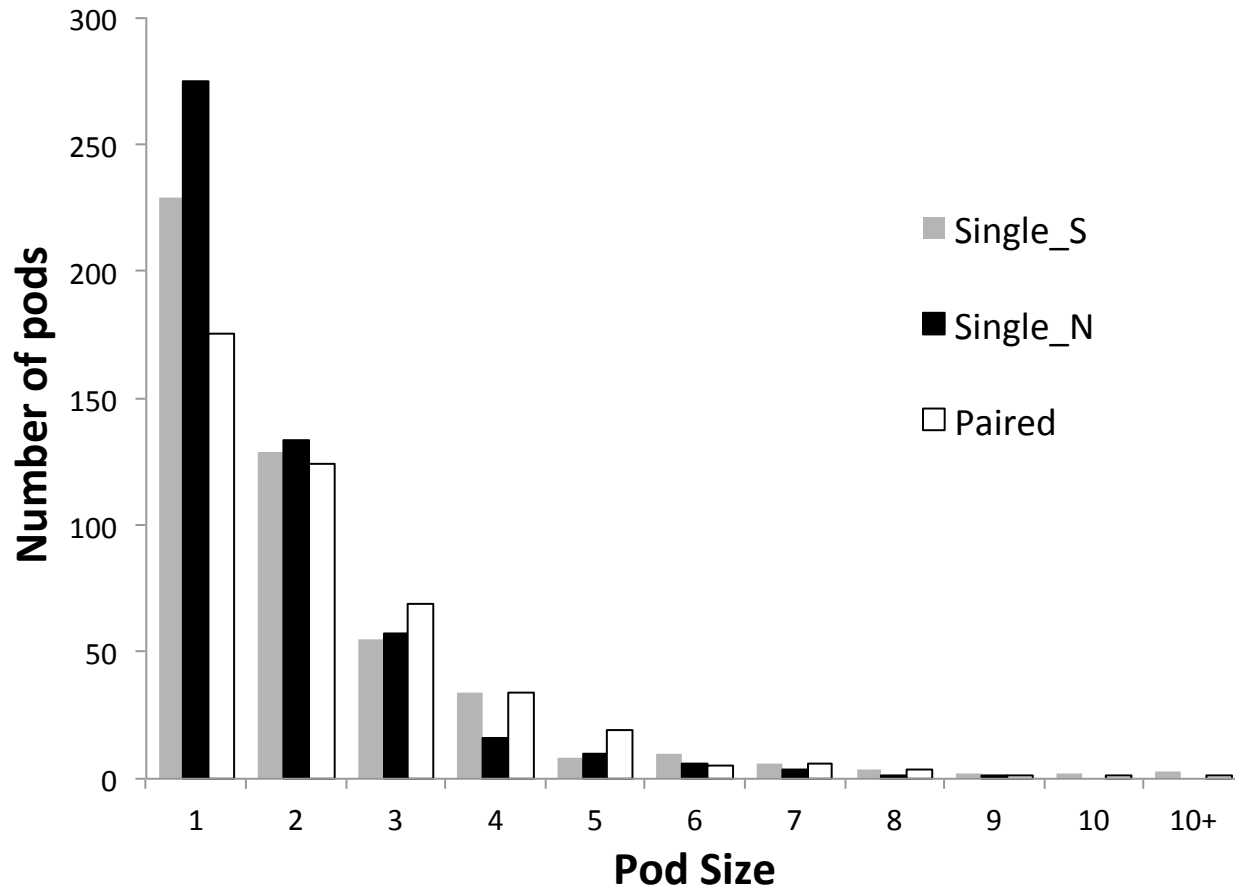
Durban et al. 2010. IWC SC/62/BRG8.

Comparative counts

MMTD migration counts were consistent, and higher than those of the old approach during simultaneous counts in 2006/2007.
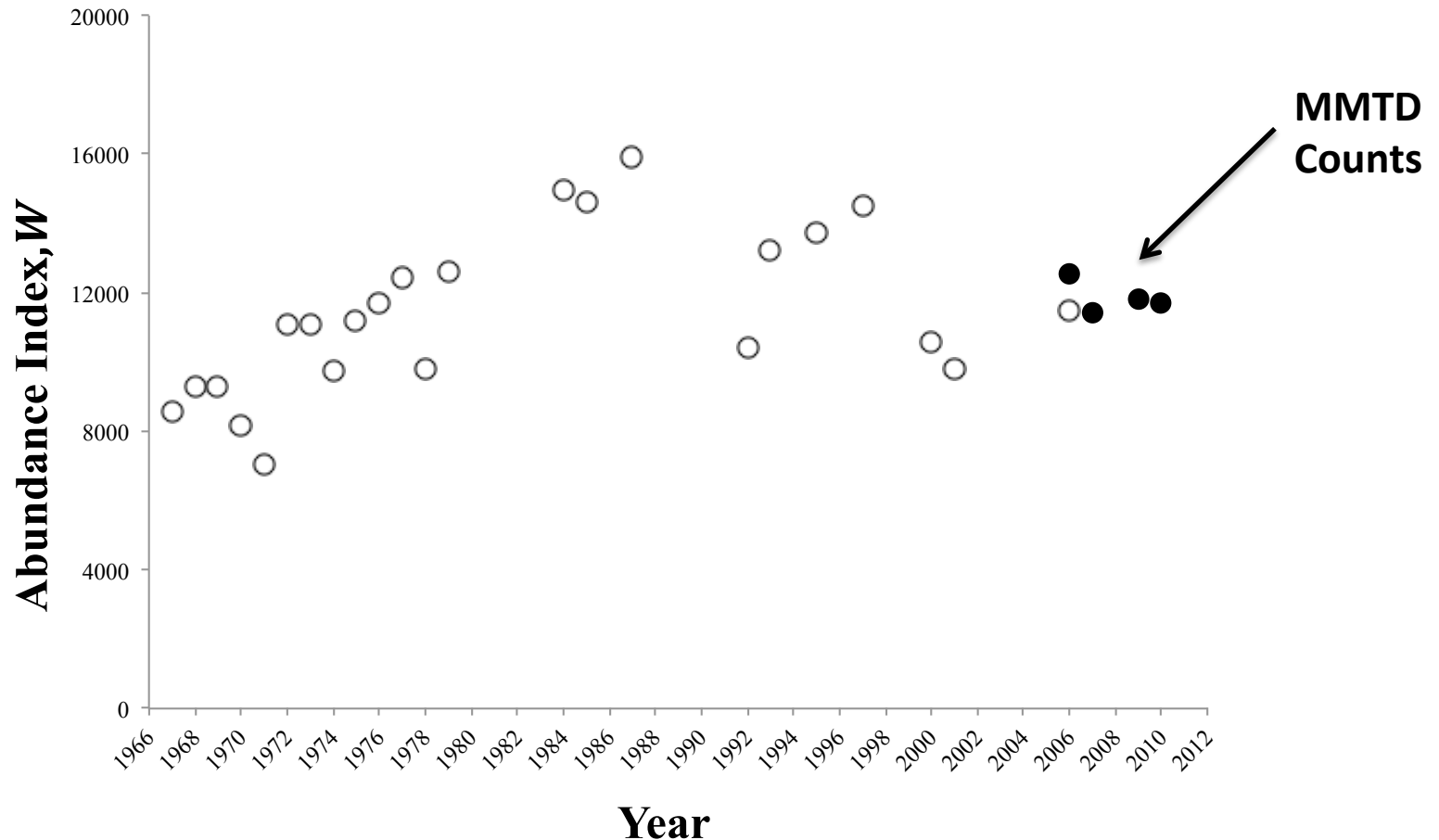
Durban et al. 2011. IWC SC/62/BRG8.

Replicate counts: Detectability

Compared counts between two paired observer teams to estimate detectability. Compared watch period counts, not specific pods

Replicate counts: "N-mixture"

Commonly used when marked animals cannot be tracked

$$n_{s,t} \sim \text{Binomial } (p_{s,t}, N_t)$$

n = watch period count, p = detectability
N = watch period abundance
t = watch period; s = station 1 or station 2

Bayesian MCMC for "simultaneous" inference

Replicate counts: "N-mixture"

Model for detection
(e.g. conditions, observers)

Model for migration trend
(common pattern, annual departures)

$$n_{s,t} \sim \text{Binomial } (p_{s,t}, N_t)$$

n = watch period count, p = detectability
N = watch period abundance
t = watch period; s = station 1 or station 2

Bayesian MCMC for "simultaneous" inference
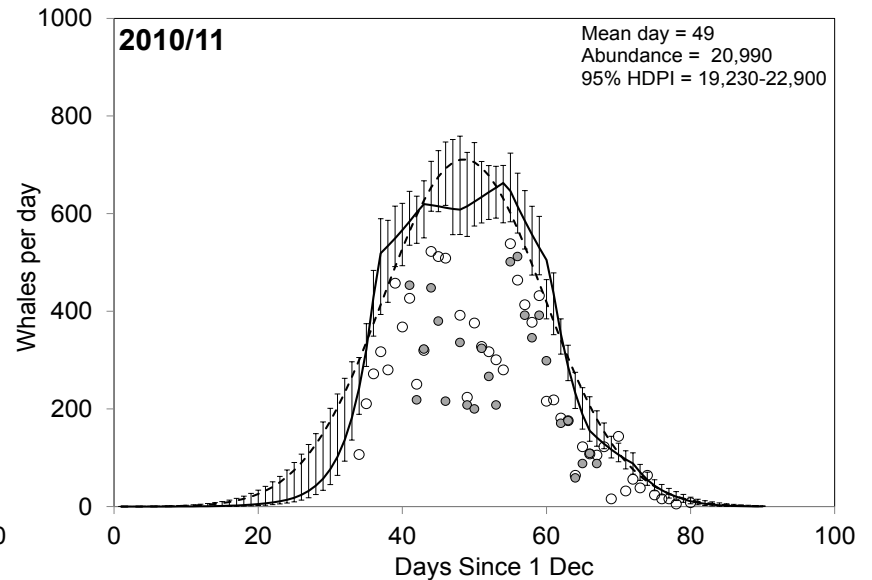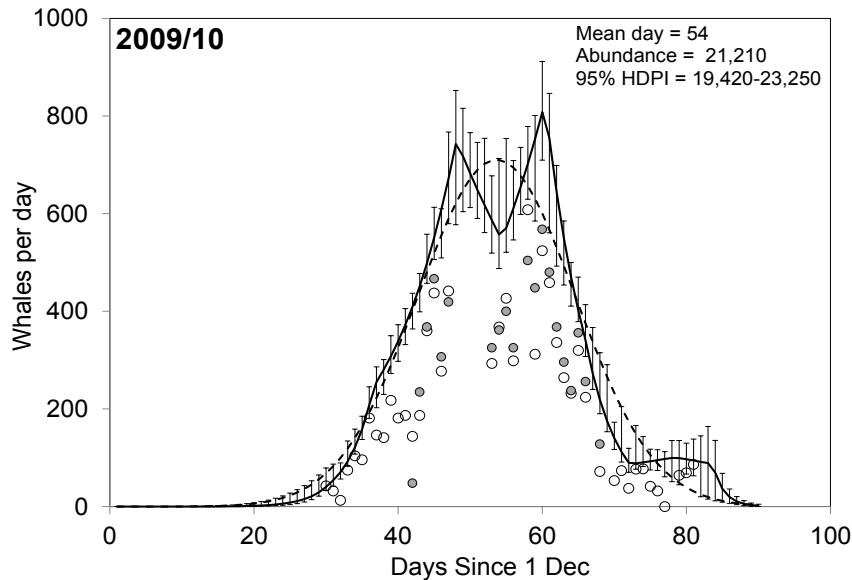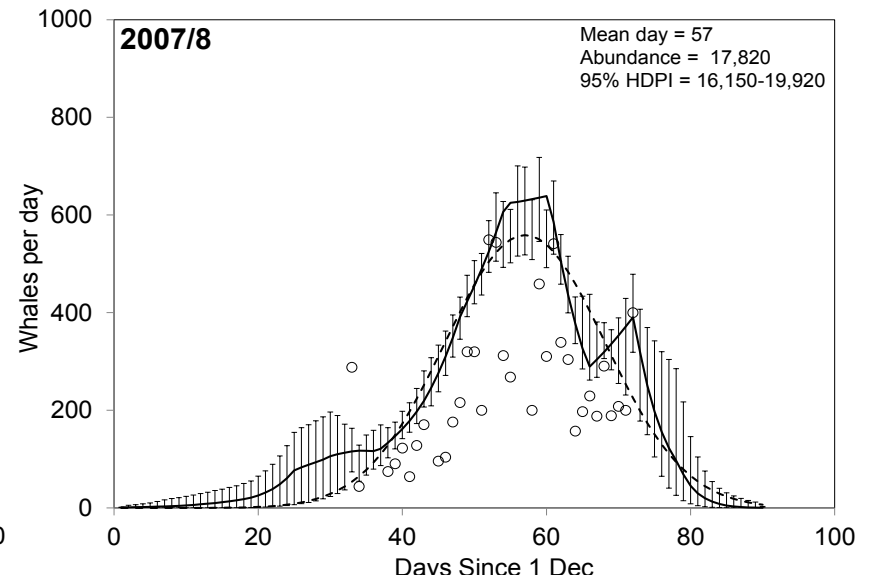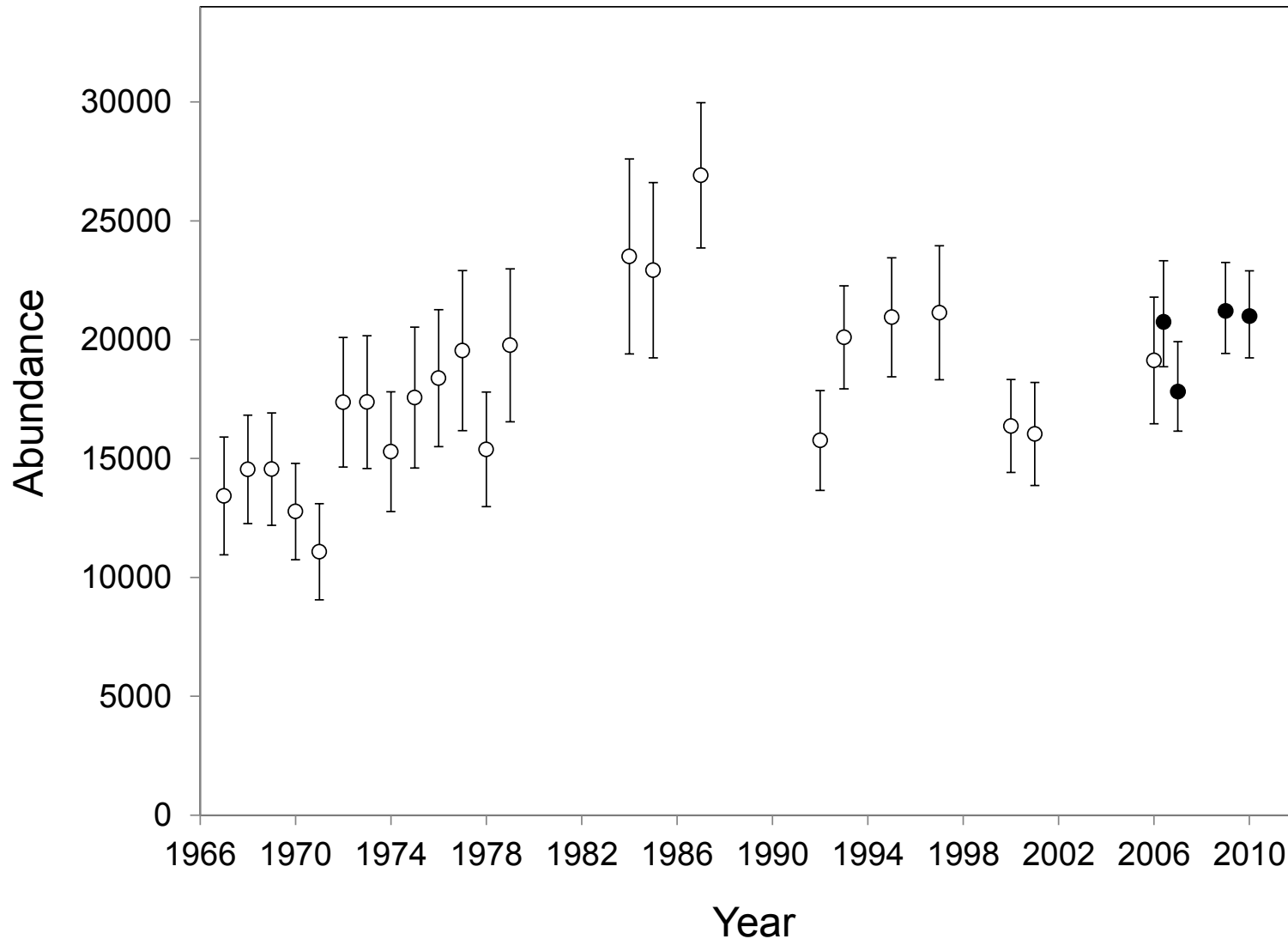
Baseline detectability = 0.80
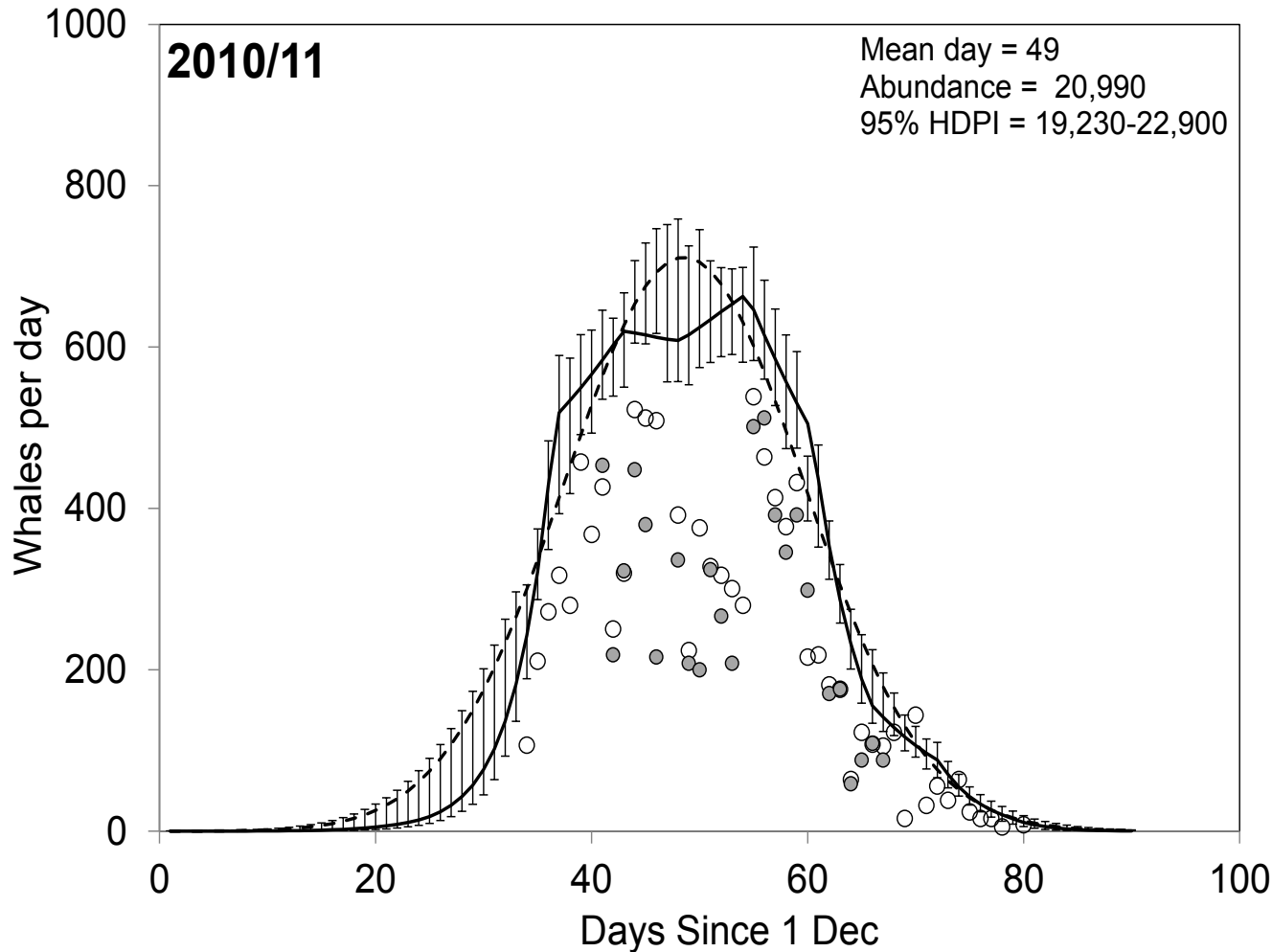
Durban et al. in press. JCRM.

Borrowing strength across years
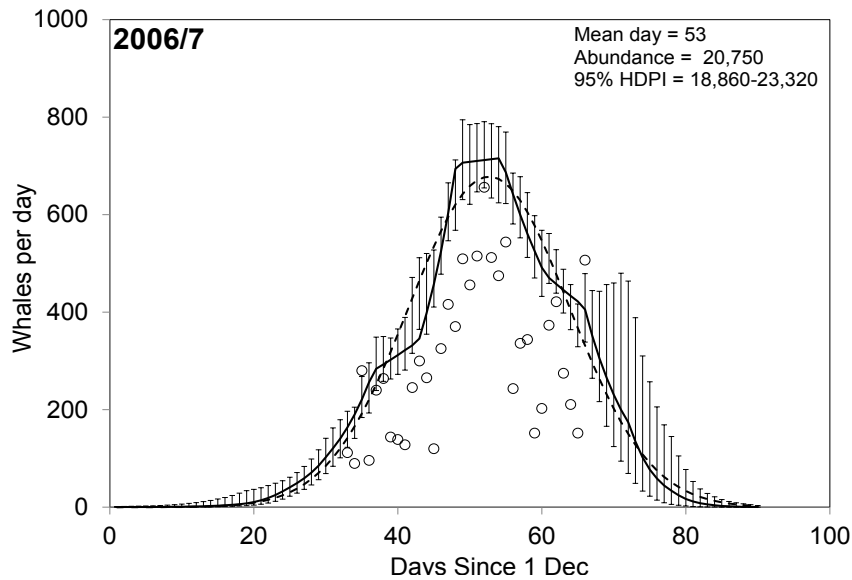
Consistent abundance estimates

Durban et al. in press. JCRM.

Removing the observer effect?

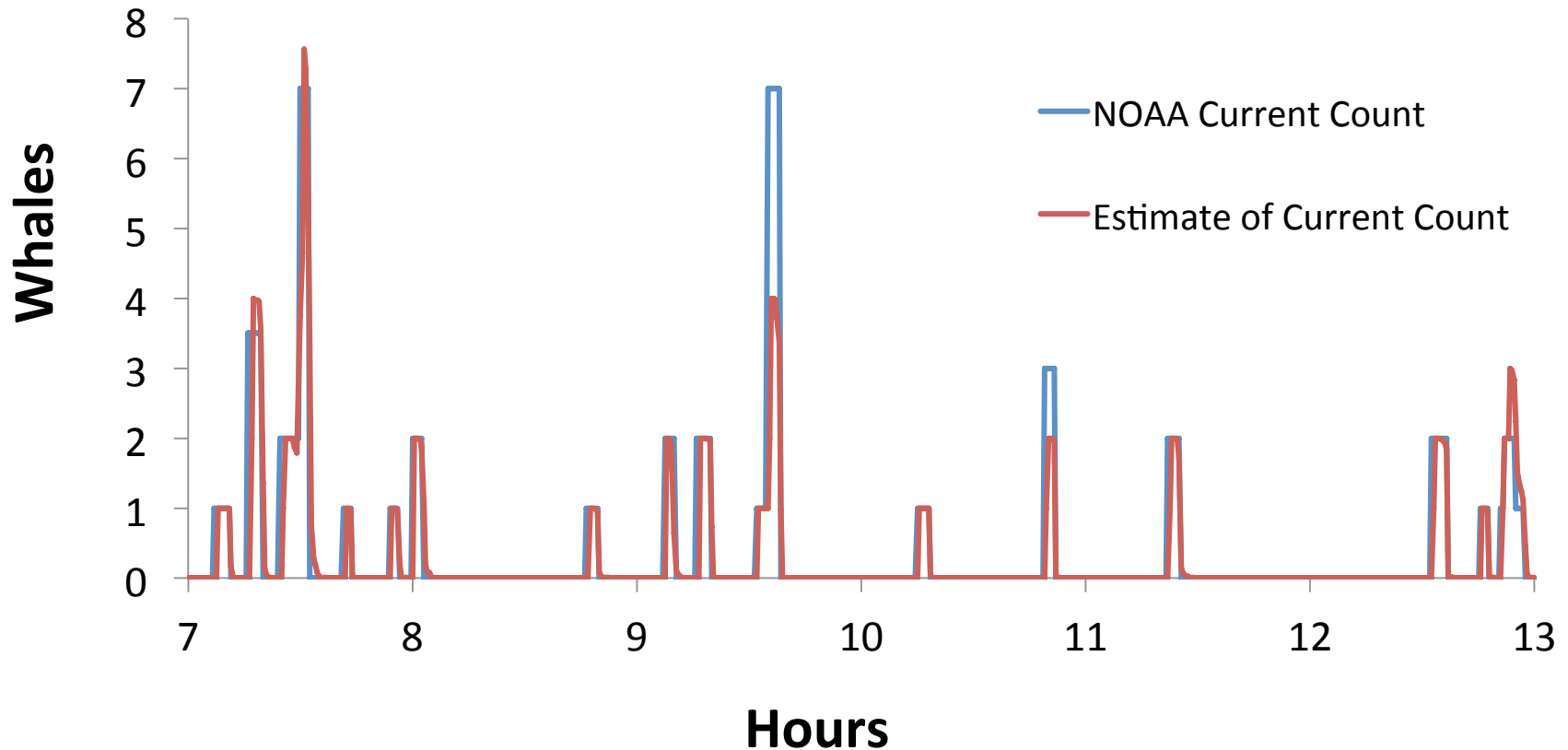Infra-red (night vision) camera system developed by Toyon, now in use at Granite Canyon. 24-hour observations.

Automated blow detection

Tracking algorithm

A model linking detections of blows to number of whales is fit using a particle filter approach

Removing the observer effect?

Observers can still review detections and refine the count, with the advantage of repeated playback to verify sightings
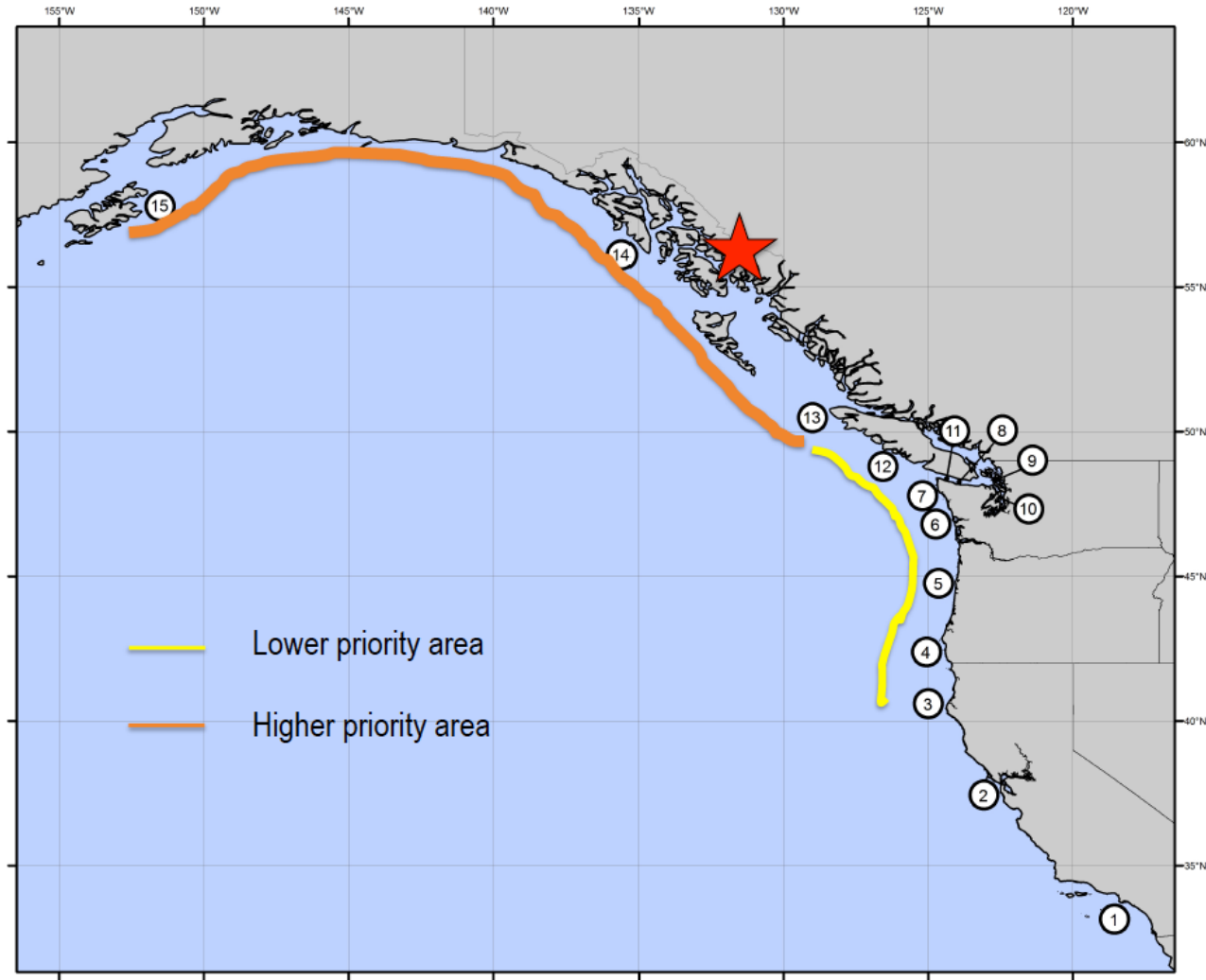
Lang [Martien], Tues am

Stock structure of gray whales in the North Pacific: whales feeding in the eastern North Pacific, western North Pacific and from the Pacific coast feeding group all migrate past central California (star).
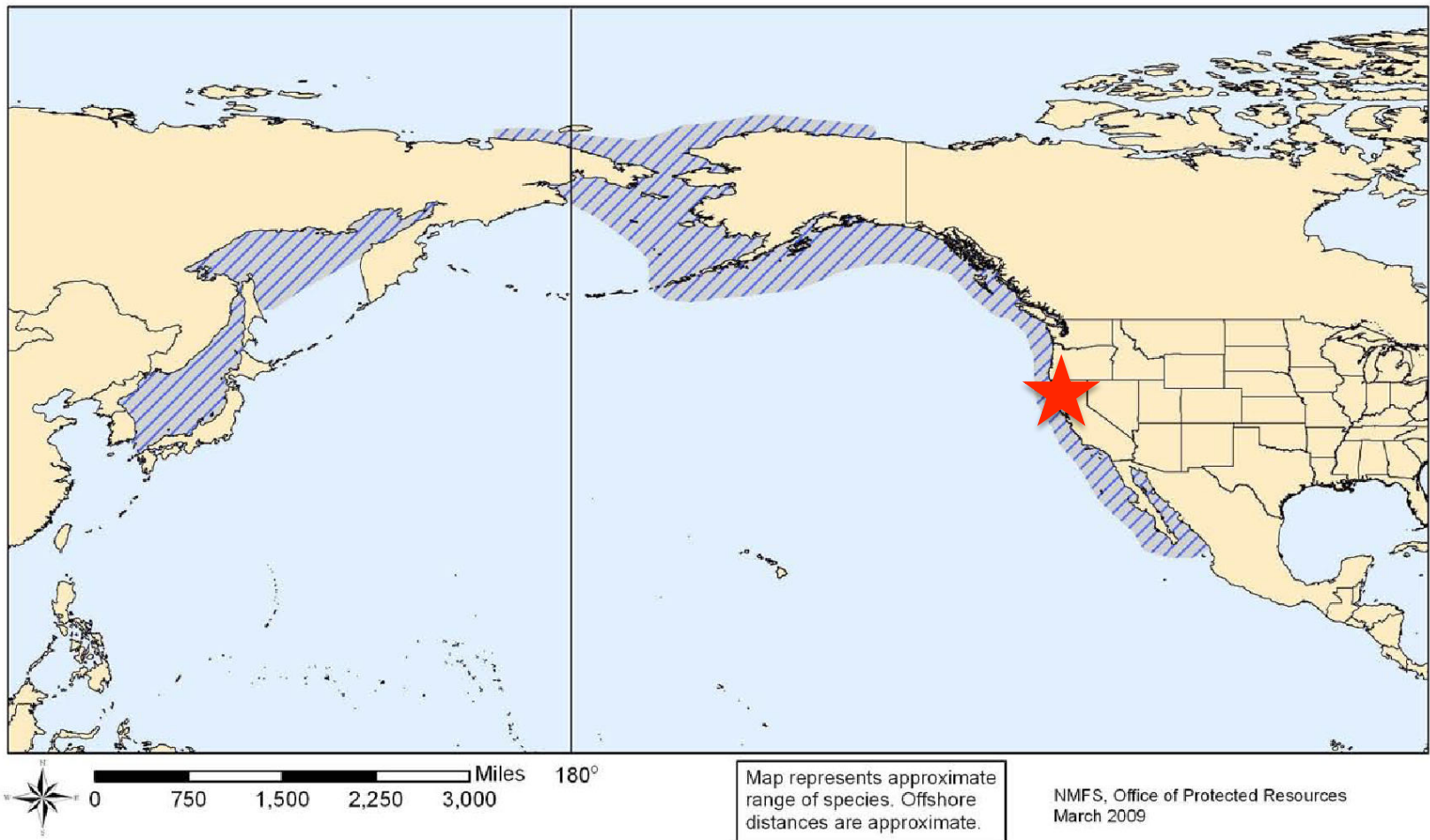
Weller, at sea

Current shipboard survey to estimate abundance of gray whales in the Pacific coast feeding group (California to Gulf of Alaska)

Durban, Wed am